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3D Water Vapor Field Campaign Concludes

Researchers from the Colorado State University recently concluded a week-long field experiment at the SGP (August 25-31, 2008) to test a new remote sensing technique to measure the three-dimensional (3D) water vapor distribution in the atmosphere. Water vapor — the main focus of the study — is a very important component of climate change studies and storm forecasting.

The researchers are interested in learning more about the variability of water vapor in the troposphere — the part of the atmosphere from the ground to an altitude of approximately six miles. To make the needed measurements, three scanning, compact microwave radiometers were deployed, each 10 kilometers (6.2 miles) apart, to form a triangle. One of the radiometers was based at the SGP Central Facility, a second was northeast of Salt Fork, Oklahoma, and the third was located three miles north of Highway 15 near Highway 74.

Microwave radiometers determine water vapor by measuring the microwave emissions of the vapor and liquid water molecules in the atmosphere at specific frequencies. The ARM Climate Research Facility deploys several microwave radiometers that can make water vapor measurements in a vertical column directly over the instrument. Scanning microwave radiometers expand on this capability by making measurements throughout a volume of the atmosphere. The scanning microwave radiometer technology has the

Figure 1. One of the three scanning, compact microwave radiometers deployed during the 3D Water Vapor Field Campaign held at the SGP site August 25-31, 2008. (Courtesy photo: Sharmila Padmanabhan, Colorado State University)

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benefit of generating volume scans that can later be pieced together in a 3D visualization of the water vapor distribution with a much finer resolution than other types of radiometers can achieve.

Measurements taken during the field campaign with the scanning, compact microwave radiometer will be compared with data from the ACRF Raman lidar and the L1 global positioning system (GPS) network. The Raman lidar uses a ground-based laser to measure atmospheric water vapor and cloud parameters, while the L1 GPS network measures 3D water vapor fields by using orbiting satellites and GPS tracking.

Figure 2. An L1 global positioning system station used in the 3D Water Vapor Field Campaign held August 25-31, 2008. (Courtesy photo: Sharmila Padmanabhan, Colorado State University)

Researchers report that very little information is available on the variability of water vapor in the troposphere over short time scales (shorter than a few hours) and over small spatial scales (smaller then a few tens of miles). Measurements of moisture with fine spatial and temporal resolution, such as those made with the scanning, compact microwave radiometer, are needed to initialize and validate numerical weather and climate models. The finely resolved measurements will, in theory, provide more accurate model forecasts and will enhance understanding of the physical processes that alter Earth's climate system.

Sensitivity studies for severe storm prediction verify the reported lack of accurate observational moisture measurements throughout the troposphere. This lack, in turn, limits the forecasting of severe storms on time scales as short as 30 minutes. The expectation is that making fine-resolution 3D water vapor measurements with the scanning microwave radiometers in areas with substantial severe weather will improve the accuracy of storm prediction, decrease the number of false alarms, and help to prevent the loss of life and property that results when warning time is insufficient.

Figure 3. Sharmila Padmanabhan of Colorado State University operates the scanning, compact microwave radiometer deployed at the field site near Highway 74, north of Highway 15 as part of the 3D Water Vapor Field Campaign held August 25-31, 2008. (Courtesy photo: Sharmila Padmanabhan, Colorado State University)